

Evaluation of SpectroVisc Q3000 for Viscosity Determination

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Prepared By:

MICHAEL PERTICH, PHD Chemist AIR-4.4.6.1

Report prepared and released by:



Naval Air Systems Command Naval Fuels & Lubricants CFT 22229 Elmer Road Patuxent River MD 20670-1534

Reviewed and Approved by:

JOHN KRIZOVENSKY Branch Supervisor AIR-4.4.6.1

GEOFFREY ELDRIDGE Chemistry Team Lead AIR-4.4.6.1

PEDRO FARIAS NOAP Program Manager AIR-4.4.6.1

Released by:

DOUGLAS F. MEARNS Fuels & Lubricants Systems Engineer AIR-4.4.1

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EXECUTIVE SUMMARY

The Navy routinely measures the viscosity of lubricating oils and hydraulic fluids. Viscosity measurements typically are conducted in a land based laboratory however the use of a handheld viscometer like the SpectroVisc Q3000 would allow for measurements onboard a Navy vessel. This would reduce the amount of time needed to obtain viscosity measurements and make the process more efficient.

Spectro Inc. furnished NAVAIR (AIR-4.4.6.1) with a SpectroVisc Q3000 handheld viscometer for the purpose of evaluating the accuracy and repeatability of the instrument using Cannon reference standards. Testing was accomplished at the NAVAIR Pensacola FL test facility in accordance with the operating procedures provided by Spectro Inc.

The accuracy and repeatability of the SpectroVisc Q3000 was evaluated using five Cannon reference standards [N10 (10 cSt), N44 (44 cSt), N100 (100 cSt), N250 (250 cSt), and N350 (310 cSt)]. These five reference standards span the reported measuring range of the SpectroVisc Q3000. The viscosity at 40° C of the five standards was determined by measuring each standard 20 times. According to Spectro Inc., the accuracy and repeatability should be $\leq 3\%$. In addition, the measured viscosities of the Cannon reference standards were compared to the results obtained using an Anton Paar viscometer. The measured viscosities for both instruments should be within 3% of each other.

NAVAIR confirmed the accuracy and repeatability statements made by Spectro Inc. concerning the capabilities of the SpectroVisc Q3000. Both the accuracy and repeatability of the SpectroVisc Q3000 were determined to be less than 3%.

Evaluation of SpectroVisc Q3000 for Viscosity Determination

1.0 BACKGROUND

The Navy routinely measures the viscosity of lubricating oils and hydraulic fluids. Viscosity measurements that are lower than expected indicate a fuel contamination while measurements that are higher than expected indicate water contamination.

Viscosity measurements typically are conducted in a land based laboratory however the use of a handheld viscometer like the SpectroVisc Q3000 would allow for measurements onboard a Navy vessel. This would reduce the amount of time needed to obtain viscosity measurements and make the process more efficient.

Spectro Inc. furnished NAVAIR (AIR-4.4.6.1) with a SpectroVisc Q3000 handheld viscometer for the purpose of evaluating the accuracy and repeatability of the instrument using Cannon reference standards. Testing was accomplished at the NAVAIR Pensacola FL test facility in accordance with the operating procedures provided by Spectro Inc.

2.0 OBJECTIVE

The objective of this testing is to evaluate the SpectroVisc Q3000 instrument for the determination of viscosity at 40°C in lubricating oils and hydraulic fluids.

3.0 APPROACH

The accuracy and repeatability of the SpectroVisc Q3000 was evaluated using five Cannon reference standards [N10 (10 cSt), N44 (44 cSt), N100 (100 cSt), N250 (250 cSt), and N350 (310 cSt)]. These five reference standards span the reported measuring range of the SpectroVisc Q3000. The viscosity at 40° C of the five standards was determined by measuring each standard 20 times. According to Spectro Inc., the accuracy and repeatability should be $\leq 3\%$.

The measured viscosities of the Cannon reference standards were compared to the results obtained using an Anton Paar viscometer. The measured viscosities for both instruments should be within 3% of each other.

4.0 DISCUSSION

The viscosity at 40°C was measured 20 times for five Cannon reference standards [N10 (10 cSt), N44 (44 cSt), N100 (100 cSt), N250 (250 cSt), and N350 (310 cSt)] using the SpectroVisc Q3000. Table 1 presents the measured viscosities.

Table 1: Viscosity at 40°C determined using the SpectroVisc Q3000

Cannon N10				Cannon N350
10 cSt	44 cSt	100 cSt	250 cSt	310 cSt
10.2	44.3	98.5	248	304
10.1	42.5	99.4	245	304
9.9	42.2	98.4	252	301
10.0	44.0	95.3	243	303
10.0	42.7	99.1	238	300
10.0	43.8	96.6	239	306
10.1	43.1	97.4	247	307
10.0	43.4	98.1	246	307
10.1	44.4	97.0	238	311
10.0	43.5	100.0	236	314
9.9	44.5	101.0	250	314
10.0	42.5	97.7	242	306
10.0	43.4	100.0	245	302
9.9	43.1	97.7	247	305
9.9	43.7	99.8	240	303
10.0	43.2	98.5	248	300
10.1	44.1	98.2	246	310
9.9	44.2	97.5	242	306
10.0	43.4	99.2	243	304
10.0	44.3	98.8	247	305
10.0	43.5	98.4	244	306
0.1	0.7	1.3	4	4
0.83	1.59	1.36	1.77	1.33
	Cannon N10 10 cSt 10.2 10.1 9.9 10.0 10.0 10.0 10.1 10.0 10.1 10.0 9.9 10.0 10.0	Cannon N10 Cannon N44 10 cSt 44 cSt 10.2 44.3 10.1 42.5 9.9 42.2 10.0 44.0 10.0 42.7 10.0 43.8 10.1 43.1 10.0 43.4 10.1 44.4 10.0 43.5 9.9 44.5 10.0 43.4 9.9 43.1 9.9 43.7 10.0 43.2 10.1 44.1 9.9 44.2 10.0 43.4 10.0 43.4 10.0 43.5 0.1 0.7	Cannon N10 Cannon N44 Cannon N100 10 cSt 44 cSt 100 cSt 10.2 44.3 98.5 10.1 42.5 99.4 9.9 42.2 98.4 10.0 44.0 95.3 10.0 42.7 99.1 10.0 43.8 96.6 10.1 43.1 97.4 10.0 43.4 98.1 10.1 44.4 97.0 10.0 43.5 100.0 9.9 44.5 101.0 10.0 43.4 100.0 9.9 43.1 97.7 9.9 43.1 97.7 9.9 43.7 99.8 10.0 43.2 98.5 10.1 44.1 98.2 9.9 44.2 97.5 10.0 43.4 99.2 10.0 43.4 99.2 10.0 43.5 98.4 10.0 43.5 9	10.2 44.3 98.5 248 10.1 42.5 99.4 245 9.9 42.2 98.4 252 10.0 44.0 95.3 243 10.0 42.7 99.1 238 10.0 43.8 96.6 239 10.1 43.1 97.4 247 10.0 43.4 98.1 246 10.1 44.4 97.0 238 10.0 43.5 100.0 236 9.9 44.5 101.0 250 10.0 43.4 100.0 245 9.9 43.1 97.7 247 9.9 43.7 99.8 240 10.0 43.2 98.5 248 10.1 44.1 98.2 246 9.9 44.2 97.5 242 10.0 43.4 99.2 243 10.0 43.4 99.2 243 10.0 43.5 98.8 247

The accuracy and repeatability of the SpectroVisc Q3000 was determined to be \leq 3% for all five of the Cannon reference standards.

The viscosity at 40° C was measured 20 times for the same five Cannon reference standards using an Anton Paar viscometer. Table 2 presents the measured viscosities for all five standards on both viscometers.

Table 2: Comparison of Measured Viscosities at 40°C

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Cannon	N10	Cannon	N44	Cannon I	V100	Cannon	N250	Cannon	N350
Anton Paar	Q3000	Anton Paar	Q3000	Anton Paar	Q3000	Anton Paar	Q3000	Anton Paar	Q3000
10.225	10.2	44.583	44.3	97.582	98.5	250.82	248	312.33	304
10.127	10.1	44.529	42.5	97.884	99.4	250.38	245	312.48	304
10.120	9.9	44.516	42.2	97.947	98.4	250.98	252	312.58	301
10.117	10.0	44.515	44.0	98.033	95.3	250.52	243	312.59	303
10.117	10.0	44.514	42.7	98.036	99.1	251.19	238	312.59	300
10.118	10.0	44.511	43.8	98.069	96.6	250.09	239	312.70	306
10.118	10.1	44.510	43.1	98.086	97.4	250.74	247	312.61	307
10.118	10.0	44.510	43.4	98.086	98.1	250.41	246	312.14	307
10.121	10.1	44.507	44.4	98.128	97.0	250.94	238	312.45	311
10.119	10.0	44.509	43.5	97.796	100.0	250.86	236	312.50	314
10.119	9.9	44.509	44.5	98.149	101.0	250.97	250	312.62	314
10.122	10.0	44.508	42.5	98.184	97.7	250.97	242	312.55	306
10.121	10.0	44.507	43.4	98.149	100.0	251.23	245	312.61	302
10.115	9.9	44.513	43.1	98.143	97.7	251.18	247	312.57	305
10.115	9.9	44.505	43.7	98.160	99.8	252.60	240	312.69	303
10.116	10.0	44.505	43.2	98.095	98.5	252.60	248	312.69	300
10.116	10.1	44.513	44.1	98.084	98.2	252.58	246	312.92	310
10.116	9.9	44.509	44.2	98.108	97.5	252.93	242	312.66	306
10.115	10.0	44.511	43.4	98.122	99.2	251.11	243	312.74	304
10.115	10.0	44.509	44.3	98.126	98.8	251.06	247	312.63	305
10.124	10.0	44.515	43.5	98.048	98.4	251.208	244	312.583	306
0.024	0.1	0.017	0.7	0.146	1.3	0.812	4	0.159	4
0.24	0.83	0.04	1.59	0.15	1.36	0.32	1.77	0.05	1.33
	Anton Paar 10.225 10.127 10.120 10.117 10.117 10.118 10.118 10.118 10.119 10.119 10.119 10.115 10.115 10.116 10.116 10.115 10.115 10.115 10.115 10.115	Cannon N10 Anton Paar Q3000 10.225 10.2 10.127 10.1 10.120 9.9 10.117 10.0 10.118 10.0 10.118 10.1 10.118 10.0 10.121 10.1 10.119 9.9 10.122 10.0 10.115 9.9 10.115 9.9 10.116 10.0 10.116 10.1 10.115 10.0 10.115 10.0 10.115 10.0 10.115 10.0 10.115 10.0 10.115 10.0 10.115 10.0 10.124 10.0 0.024 0.1	Cannon N10 Cannon Anton Paar Q3000 Anton Paar 10.225 10.2 44.583 10.127 10.1 44.529 10.120 9.9 44.516 10.117 10.0 44.515 10.117 10.0 44.514 10.118 10.0 44.511 10.118 10.1 44.510 10.118 10.0 44.510 10.121 10.1 44.507 10.119 10.0 44.509 10.119 9.9 44.508 10.121 10.0 44.508 10.121 10.0 44.507 10.115 9.9 44.505 10.116 10.0 44.505 10.116 10.0 44.505 10.116 10.0 44.513 10.115 10.0 44.509 10.115 10.0 44.509 10.115 10.0 44.509 10.124 10.0 44.515	Cannon N10 Cannon N44 Anton Paar Q3000 Anton Paar Q3000 10.225 10.2 44.583 44.3 10.127 10.1 44.529 42.5 10.120 9.9 44.516 42.2 10.117 10.0 44.515 44.0 10.117 10.0 44.514 42.7 10.118 10.0 44.511 43.8 10.118 10.1 44.510 43.1 10.118 10.1 44.510 43.4 10.121 10.1 44.507 44.4 10.119 10.0 44.509 43.5 10.119 9.9 44.509 44.5 10.121 10.0 44.508 42.5 10.121 10.0 44.507 43.4 10.115 9.9 44.507 43.4 10.115 9.9 44.505 43.7 10.116 10.0 44.505 43.2 10.116 10.0 44.509 <td>Cannon N10 Cannon N44 Cannon N44 Anton Paar Q3000 Anton Paar Q3000 Anton Paar 10.225 10.2 44.583 44.3 97.582 10.127 10.1 44.529 42.5 97.884 10.120 9.9 44.516 42.2 97.947 10.117 10.0 44.515 44.0 98.033 10.117 10.0 44.514 42.7 98.036 10.118 10.0 44.514 42.7 98.036 10.118 10.0 44.511 43.8 98.069 10.118 10.1 44.510 43.1 98.086 10.118 10.0 44.510 43.4 98.086 10.121 10.1 44.507 44.4 98.128 10.119 10.0 44.509 43.5 97.796 10.122 10.0 44.508 42.5 98.184 10.121 10.0 44.507 43.4 98.149 10.115</td> <td>Cannon N10 Cannon N44 Cannon N100 Anton Paar Q3000 Anton Paar Q3000 Anton Paar Q3000 10.225 10.2 44.583 44.3 97.582 98.5 10.127 10.1 44.529 42.5 97.884 99.4 10.120 9.9 44.516 42.2 97.947 98.4 10.117 10.0 44.515 44.0 98.033 95.3 10.117 10.0 44.514 42.7 98.036 99.1 10.118 10.0 44.511 43.8 98.069 96.6 10.118 10.1 44.510 43.1 98.086 97.4 10.118 10.1 44.510 43.1 98.086 97.4 10.118 10.0 44.510 43.4 98.086 98.1 10.119 10.0 44.507 44.4 98.128 97.0 10.119 9.9 44.509 44.5 98.149 101.0 10.121 <</td> <td>Cannon N10 Cannon N44 Cannon N100 Cannon Anton Paar Q3000 Anton Paar Q3000</td> <td>Anton Paar Q3000 Anton Paar Q3000 Anton Paar Q3000 Anton Paar Q3000 10.225 10.2 44.583 44.3 97.582 98.5 250.82 248 10.127 10.1 44.529 42.5 97.884 99.4 250.38 245 10.120 9.9 44.516 42.2 97.947 98.4 250.98 252 10.117 10.0 44.515 44.0 98.033 95.3 250.52 243 10.117 10.0 44.514 42.7 98.036 99.1 251.19 238 10.118 10.0 44.511 43.8 98.069 96.6 250.09 239 10.118 10.1 44.510 43.1 98.086 97.4 250.74 247 10.118 10.0 44.501 43.4 98.086 98.1 250.41 246 10.119 10.0 44.507 44.4 98.128 97.0 250.94 238</td> <td>Cannon №10 Cannon №44 Cannon №250 Cannon Anton Paar Q3000 Anton Paar Q4250 A15 Q50.40 Q50.30</td>	Cannon N10 Cannon N44 Cannon N44 Anton Paar Q3000 Anton Paar Q3000 Anton Paar 10.225 10.2 44.583 44.3 97.582 10.127 10.1 44.529 42.5 97.884 10.120 9.9 44.516 42.2 97.947 10.117 10.0 44.515 44.0 98.033 10.117 10.0 44.514 42.7 98.036 10.118 10.0 44.514 42.7 98.036 10.118 10.0 44.511 43.8 98.069 10.118 10.1 44.510 43.1 98.086 10.118 10.0 44.510 43.4 98.086 10.121 10.1 44.507 44.4 98.128 10.119 10.0 44.509 43.5 97.796 10.122 10.0 44.508 42.5 98.184 10.121 10.0 44.507 43.4 98.149 10.115	Cannon N10 Cannon N44 Cannon N100 Anton Paar Q3000 Anton Paar Q3000 Anton Paar Q3000 10.225 10.2 44.583 44.3 97.582 98.5 10.127 10.1 44.529 42.5 97.884 99.4 10.120 9.9 44.516 42.2 97.947 98.4 10.117 10.0 44.515 44.0 98.033 95.3 10.117 10.0 44.514 42.7 98.036 99.1 10.118 10.0 44.511 43.8 98.069 96.6 10.118 10.1 44.510 43.1 98.086 97.4 10.118 10.1 44.510 43.1 98.086 97.4 10.118 10.0 44.510 43.4 98.086 98.1 10.119 10.0 44.507 44.4 98.128 97.0 10.119 9.9 44.509 44.5 98.149 101.0 10.121 <	Cannon N10 Cannon N44 Cannon N100 Cannon Anton Paar Q3000 Anton Paar Q3000	Anton Paar Q3000 Anton Paar Q3000 Anton Paar Q3000 Anton Paar Q3000 10.225 10.2 44.583 44.3 97.582 98.5 250.82 248 10.127 10.1 44.529 42.5 97.884 99.4 250.38 245 10.120 9.9 44.516 42.2 97.947 98.4 250.98 252 10.117 10.0 44.515 44.0 98.033 95.3 250.52 243 10.117 10.0 44.514 42.7 98.036 99.1 251.19 238 10.118 10.0 44.511 43.8 98.069 96.6 250.09 239 10.118 10.1 44.510 43.1 98.086 97.4 250.74 247 10.118 10.0 44.501 43.4 98.086 98.1 250.41 246 10.119 10.0 44.507 44.4 98.128 97.0 250.94 238	Cannon №10 Cannon №44 Cannon №250 Cannon Anton Paar Q3000 Anton Paar Q4250 A15 Q50.40 Q50.30

The measured viscosities for both instruments were determined to be within 3% of each other.

5.0 CONCLUSIONS

NAVAIR substantiated the accuracy and repeatability statements made by Spectro Inc. concerning the capabilities of the SpectroVisc Q3000. Both the accuracy and repeatability of the SpectroVisc Q3000 were determined to be less than 3%.

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14. ABSTRACT

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